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INIATION THESIS
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THE THOMAS VIADUCT AT RELAY, MARYLAND

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FOR

ADMISSION TO

^{OR}
THE PHI MU HONARY ENGINEERING FRATERNITY
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OF

¹
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THE THOMAS VIADUCT



The oldest stone arch railroad bridge in the world, built at Relay, Md., in 1835, still bearing heavy B. & O. traffic after 89 years of continuous service

This paper is respectfully dedicated to the early engineers of the Baltimore and Ohio Railroad Company, pioneers in American railroad construction and men whose achievements are resplendent with great accomplishments.

The author wishes to express in full measure his appreciation of the assistance received from the Baltimore and Ohio Railroad through Mr. R. E. Kennedy, Valuation Engineer, without whose aid this paper could not have been written.

THE THOMAS VIADUCT AT RELAY, MARYLAND

INTRODUCTION

The Thomas Viaduct, which spans the picturesque valley of the Patapsco River at Relay, Maryland, is unique in many ways. It has the distinction of being the oldest stone arch railroad bridge in the world and is one of the few masonry viaducts that are constructed on a curve instead of a tangent. It is with these and other more important features of this early accomplishment of American engineers that this paper is chiefly concerned.

EARLY HISTORY

The history of the Thomas Viaduct rightfully begins in 1833 when the list of estimates for masonry on the new lateral railroad from Baltimore to Washington included as its first and most important item the data on a bridge to carry the tracks across the Patapsco at Relay. A structure of eight arches, each of 58 foot span, with the roadway 66 feet above the surface of the water was called for. It was calculated that for the stonework 20,000 perches of 25 cubic feet would be required, that the price per perch would be \$ 6.00, and that the net cost would be \$ 120,000.

The bridge was designed by B. H. Latrobe, an assistant engineer in the employ of the Baltimore and Ohio Company, who had played an important part in the survey of the Washington Branch and had submitted the estimates. After the specifications had been approved by the directors, the contract was awarded to John Mc Cartney of Ohio. Work was start-

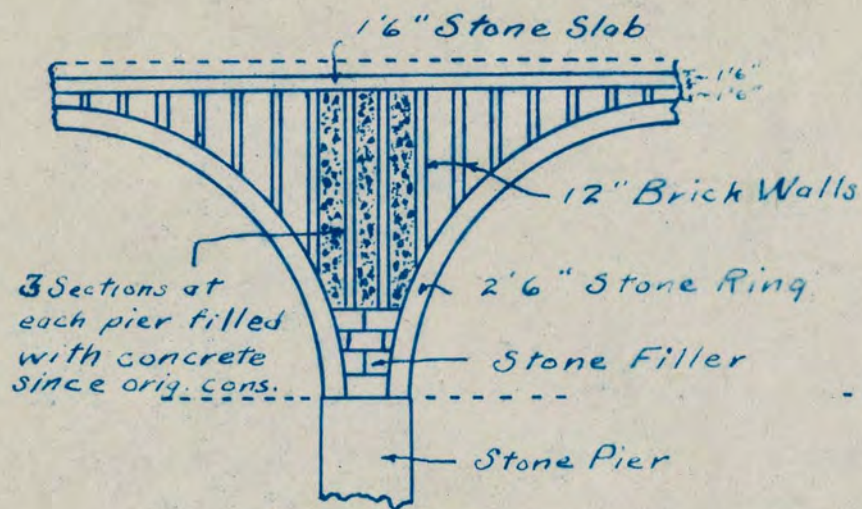
ed on the 4th of July, 1833 and completed on the 4th of July, 1835. It was properly named the Thomas Viaduct in honor of the first president of the road.

Records of the bridge during the period of construction are entirely lacking and the original designs and working drawings are not available. The structure as it now exists is essentially the same as it was in 1835, and by a survey of its present dimensions and details of construction a comprehensive impression may be obtained of the magnitude of the work so ably executed by these early pioneers in the new field of railroad building.

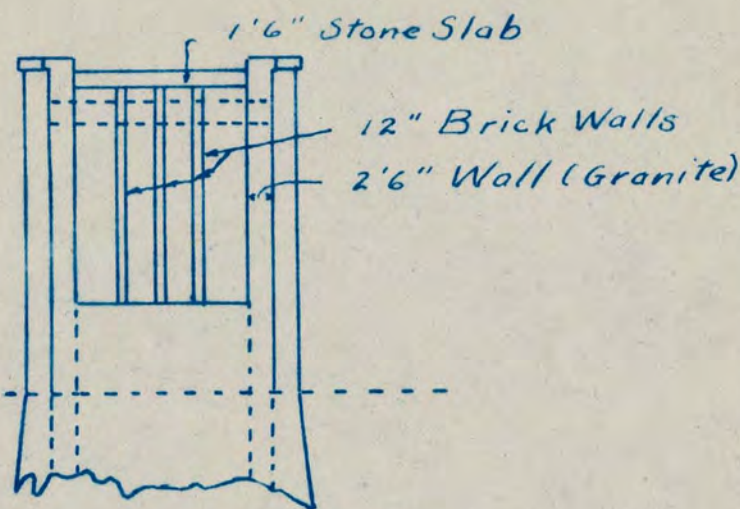
DETAILS OF CONSTRUCTION

ACTUAL DIMENSIONS

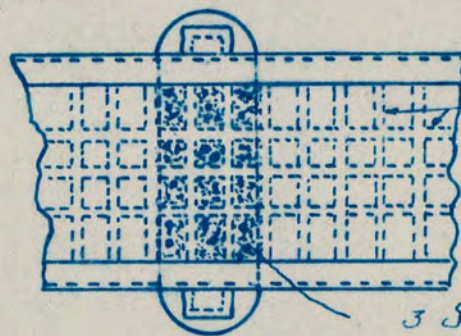
The following data on the Viaduct was obtained from the office of the Bridge Engineer of the Baltimore and Ohio Railroad Company. The structure is built on a curve 4 degrees and 23 minutes to a line going west and has a .14 % descending grade, also going west. Its total length is 612 feet and the width is 23 feet 4 inches, out to out. The height from the ground to the parapet is 54 feet. The eight spans have lengths varying from 57 feet $10\frac{1}{4}$ inches to 58 feet $4\frac{1}{2}$ inches. The bridge carries a double track roadway which has a superelevation of $5\frac{3}{4}$ inches. The approach curves are both sharper curves than that of the bridge and the speed is limited to about 30 miles an hour. On the upstream or convex side there is a foot path which overhangs the exterior wall and is enclosed by a strong iron railing.



Longitudinal



Cross



Plan

Data

All stone work is Maryland granite
 On curve $4^{\circ}23'$ to Lt. going West
 Grade .14 % descending going West
 Length 612'
 Width 23'4" o to o
 Height 54' ground to parapet
 Spans 8 @ 57'-10 $\frac{1}{4}$ " to 58'-4 $\frac{1}{2}$ "

Scale 1" = 20'-0"

THE THOMAS VIADUCT

RELAY, MD

Traced by J. E. Revell

Drawn by R. E. Kennedy, Engr. B and O.

STONE WORK

The stones are all of Maryland granite obtained from the nearby quarries in the valley of the Patapsco. The work is of a rustic nature, that is, the stones are dressed around the edges and left rough and unhewn in the center.

It is interesting to note in this connection that one of the officials strongly opposed the use of this style of masonry. This individual would not waive his objections until Contractor Mc Cartney, who was then building the Patterson Viaduct on the old main line, "took the trouble to erect at the quarry a wall in which the expense and appearance of the rustic work was contrasted with that of dressed or faced work, obviously to the disadvantage of the latter."

The arches are supported on large stone piers. The security of the foundations is beyond doubt, for the entire valley is of a rocky formation and the location of bed rock was probably a comparatively easy task. The arch stones are in the form of a ring 2 foot 6 inches thick with stone fillers over each pier. The 1 foot 6 inch stone slabs under the roadbed are supported by number of 12 inch brick walls, 4 feet apart, which rest on the stones of the arches. These hollow columns have the appearance when the roadway and covering slabs are removed of a honey comb of brick chimneys. The vertical granite walls are 2 feet 6 inches thick.

SPECIFICATIONS OF THE COMPANY

The instructions issued to the contractors in 1833 by Casper

Wever, Superintendent of Graduation and Masonry, contained the following articles:

"(1) All masonry in the bridge shall be of a rubble character excepting the face work of the abutments and the sheeting of the arches, and shall be well laid in good mortar.

(2) The faces of the abutments shall be rough in their exterior, but the stone shall be ranged and dressed bed and top, and have vertical joints. The sheeting stone shall be cut or shaped so as to range transversely of the arch, and conform to the radii of the circle or circles of which the arch may be a segment.

(3) No ardent spirits are to be kept or used near the work." These specifications, with the probable exception of the last one, were strictly observed by Mc Cartney in the building of the Thomas Viaduct.

COST

The ease with which the stone was procured from the quarries of the Patapsco on the line of the railroad did much to moderate the expense of construction. The final total cost of the bridge was \$ 128,260.20. Although the prices were different for the various kinds of stone work, it is probable that the average was about \$ 6.00 per perch of 25 cubic feet, that is, almost a cubic yard. The cost of earth work at that time was about \$ 0.25 per yard. The above price includes \$ 6,000.00 for 4,000 perches of rubble stone deposited around one of the abutments and some of the piers for securing the foundations more firmly. Deducting this amount from the above figure brings the final cost ^{within} \$ 2,260.00 of the original

estimate for net cost submitted by Latrobe. The total amount of stone used was 19,604 perches; the estimated amount 20,000 perches. The slight differences reflect well upon the ability of the designer to estimate the cost of masonry construction.

REPAIRS

In engineering works, however, the initial cost is not always of the greatest importance. The lack of upkeep expenses on the Thomas Viaduct has been one of its most remarkable features. During 89 years of continuous service under the heaviest of traffic, only a minimum amount of repairs have been necessary. In the arches, some of the stones which had settled slightly were jacked back in place and secured with cement. The three sections of brick columns which support the section of the roadway directly over each pier have been filled with concrete. These slight alterations have rendered the viaduct fully as strong as it originally was. It is the opinion of the engineers of the Baltimore and Ohio Railroad that the structure will stand without alteration for many more years unaffected by either the elements or the annually increasing loads which it must bear many times each day.

DURABILITY OF THE STRUCTURE

After a consideration of the fact that this viaduct, almost a century old, and designed for engines less than five tons in weight, now supports the modern thirty ton locomotives and is capable of upholding still greater loads, the question naturally arises as to whether it was the intentions of the designer to build so strong a structure.

It is not probable that young Latrobe was fully cognizant of the vast capacity of his bridge, nor is it likely that even in his most imaginative moods he could have even partially visualized the stupendous increase ~~increase~~ in the weight and size of railroad rolling stock. It must be remembered that at that period the design of bridges was not the exact science of this age and that the construction of railroad bridges was a new field in which ^{there were} no precedents or rules to be followed.

That permanency was desired by the directors of this first American railroad can easily be demonstrated. Some of the early bridges and culverts had been built of wood and by 1833 the company ^{was} ~~had been~~ thoroughly impressed, as the following statement from the Seventh Annual Report to the Stockholders reveals, with the necessity of eliminating as far as possible upkeep expenses.

"In the construction of the Washington Road, the board had regard to its durability, not less than to making it a source of immediate profit to those interested in the undertaking. True economy consists, in the first place, in constructing the road so as to obviate the necessity of frequent repairs, and to enable the motive power to be employed to its fullest effects without injury to the bridges or roads over which it passes in the performance of its daily work. The board have, therefore, caused all viaducts to be built of stone of the most permanent yet simple construction."

That the employees of the road were well satisfied with the structure is brought out in the report of Johnathan Knight, Chief Engi-

neer of the Road.

"The massive materials of which the Thomas Viaduct is built, the care that has been taken in putting them together, and their foundation on solid rock, are guarantees of its continuing durability."

This assurance was, however, by no means universal during the two years of construction. The design met with much opposition and many engineers expressed doubt of its stability. The bridge was often referred to as "Latrobe's Folly." Notwithstanding this, he persisted, and time has fully justified his faith in himself and his bridge.

B.H. LATROBE, THE DESIGNER

B. H. Latrobe, the designer of the Thomas Viaduct, came from a family of no mean accomplishments. It included a noted writer, the architect of the Capitol Building at Washington, and the first corporation counsel of the Baltimore and Ohio Railroad. Latrobe was educated for a lawyer but soon found that his inclinations ran in a counter direction, and being already a skillful draughtsman and an accomplished mathematician he obtained employment as an assistant engineer. His commendable record in the early surveys and designs enabled him to succeed Jonathan B. Knight, Chief Engineer of the Baltimore and Ohio during the first fourteen years of its existence.

JOHN MC. CARTNEY, THE CONTRACTOR.

John Mc. Cartney of Ohio the contractor who erected the Thomas Viaduct was favorably known to the stockholders of the company as the builder of the Patterson Bridge on the old main line. He was an ardent advocate of the rustic type of masonry. The contractor was very proud of

his part in the building of what was then the largest structure of its kind in the United States and he expressed his feelings in two distinctly different ways. The following synopsis of an article from "The Broadside," one of the early single sheet newspapers of Baltimore, reveals how the people of that city reacted to the first of these expressions.

"Mc. Cartney, the builder of the Viaduct over the Patapsco, gave a frolic at the closing of the arches. After the men were made drunk, he ordered them to kneel before him, and in that situation baptised them by pouring on their heads a pint of whiskey. This violation of the Holy Rites of religion took place on the Baltimore and Ohio Railroad in the vicinity of Ellicot Mills, the office of his warm friend and supporter, the superintendent of the road, being in the distance."

MC. CARTNEY'S MONUMENT.

In order to perpetrate his connection with the work as well as that of the original projectors and directors of the road, Contractor Mc. Cartney had erected at his own expense, at the abutment near the Relay House, a granite obelisk. The shaft is about 15 feet in height and pyramidical in shape. On each of the four sides are suitable inscriptions giving the dates of construction and the names of those associated with the building of the viaduct. Near the bottom in small and modest letters appears the statement that the monument was erected by John Mc. Cartney.

IMPORTANCE OF THE THOMAS VIADUCT.

The importance of the Thomas Viaduct was not confined to the early years of its existence. During the Civil War the bridge was a point of paramount military value, for the cars of the Pennsylvania were

then running on the Baltimore and Ohio tracks and all the railroad traffic to stations below Baltimore had to pass over the viaduct.

In order to frustrate any attempt of the Confederates to destroy the bridge , a detachment of soldiers guarded it night and day and forced all pedestrians to cross the river over the bridge on the Washington Boulevard.

The real significance of the Thomas Viaduct lies, however, not in its former military importance nor its present commercial value, but in the splendid tribute it pays to the skill, the ability and the indomitable perseverance of those early American engineers, who were pioneers in a new field of endeavor and who recognized no such word as failure.

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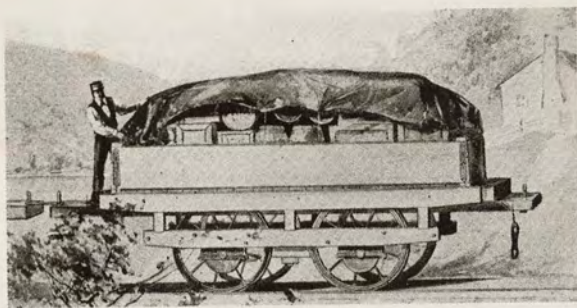
5. B and O Magazine for November 1921

6. Rambles in the Path of a Steam Horse

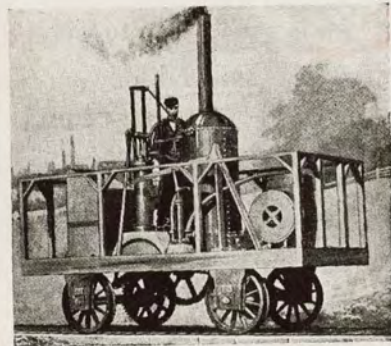
Eli Brown

7. The Office of the Bridge Engineer of the Baltimore and Ohio Railroad through the kindness of Mr. Kennedy.

Type of engine and car for which the Thomas Viaduct was designed

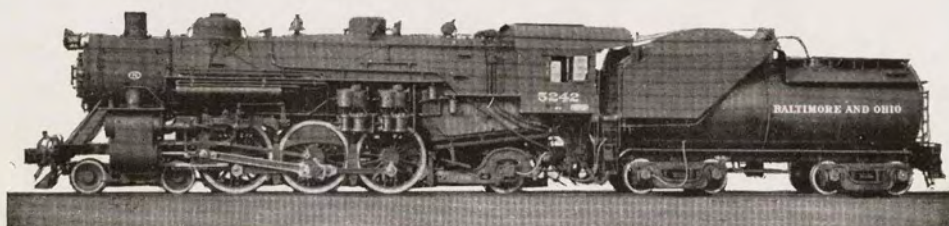


*This is a B. & O. freight car of 1832—
the first operated by the road*



*This is a reproduction of an old print
of Peter Cooper's "Tom Thumb," the
first locomotive of the Baltimore & Ohio
Railroad, which was built in this
country in 1830*

Type of engine now in use



*Quite in contrast to the "Tom Thumb" is
this modern coal-burning Baltimore & Ohio
passenger engine of today*

The Valley of the Patapsco from the Bridge









Mc Cartney's Monument



